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AVERAGE P AND PKP CODAS FOR EARTHQUAKES (103 DEGREES - 118 DEGREES)

E. I. Sweetser, et al

Teledyne Geotech

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An analysis of seismograms of 26 small events ($m_b \leq 5.8$) recorded at a world-wide network of 10 stations, and of 26 large events (m_b, M_s, or secondary $m_b \geq 7.0$) recorded at a world-wide network of 16 stations, yielded an estimate of the coda decay characteristics for events in the distance interval 103-118°. For times greater than the arrival time for the PP phase, large event codas are about 0.11 m_b units greater than small event codas at corresponding times into the codas. This supports the hypothesis that large events are multiple

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AVERAGE P AND PKP CODAS FOR EARTHQUAKES (103° - 118°)

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ABSTRACT

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INTRODUCTION

The coda analyses presented in this report complement our previous studies of P and PKP codas for earthquakes (Cohen et al., 1972; Sweetser et al., 1973), and specifically detail coda characteristics in the distance interval 103 to 118°. Earlier studies performed using seismograms recorded at a network of Worldwide Standard Seismograph Stations (WWSSS) did not adequately define coda characteristics in this interval, especially for small events (NOS $m_b \leq 5.8$) recorded at distances where P_{diff} is the first arrival. Because coda determinations are often used to determine how often signals from one event are masked in the coda of another event, it is necessary to have a complete set of coda observations with which to predict coda for a specified event. The purpose of this report, then, is to augment our present coda observations (Sweetser et al., 1973) with information on large- and small-event coda characteristics in the distance interval 103 to 118°.

ANALYSIS TECHNIQUES

The methods used to determine coda decay characteristics, and to determine quantitatively the difference in coda levels for large and small events, are described by Sweetser et al. (1973). Because coda characteristics are determined primarily by the arrival times and relative amplitudes of significant secondary phases, events are grouped by the distance intervals given in Tables I and II.

TABLE I

P-Coda Distance Intervals

1.	0 - 5°		
2.	5 - 10°		
3.	10 - 14°		
4.	14 - 16°		
5.	16 - 21°		
6.	21 - 22°		
7.	22 - 24°		
8.	24 - 26°		
9.	26 - 29°		
10.	29 - 31°		
11.	31 - 42°		
12.	42 - 53°		
13.	53 - 56°		
14.	56 - 59°		
15.	59 - 63°		
16.	63 - 67°		
17.	67 - 72°		
18.	72 - 79°		
19.	79 - 84°		
20.	84 - 98°		
21.	98 - 103°		
22.	103 - 105°	This Report	
23.	105 - 110°		

TABLE II

PKP-Coda Distance Intervals

1.	110 - 115°	This Report
2.	115 - 118°	This Report
3.	118 - 127°	
4.	127 - 136°	
5.	136 - 140°	
6.	140 - 145°	
7.	145 - 155°	
8.	155 - 166°	
9.	166 - 180°	

RESULTS

Coda Characteristics as a Function of Magnitude

Using data in the distance interval 103-118°, we first determine if any difference exists between the relative coda amplitudes for large and small events. That is, we seek the dependence of coda characteristics on event magnitude. In earlier work (Sweetser et al., 1973) we divided the earthquake population into two sets based on event magnitude. We defined a "large event" as one having an NOS m_b, NOS M_s, or secondary m_b (at an observatory such as Pasadena or Berkeley) of 7.0 or larger. On the other hand a "small event" was defined as having $m_b \leq 5.8$. The same definitions are used here, and thus the events shown in Tables III and IV constitute the large event population while the events shown in Tables VI and VII constitute the small event population. Note that the data consists of seismograms for events recorded at Worldwide Standard Sesimograph Stations (WWSSS) and observatory station TFO (Cohen et al., 1972; Sweetser et al., 1973), in addition to seismograms for events recorded at observatory stations CPO, LAO, TFO, UBO and WMO, the Large Aperature Seismic Array (LASA) and the Long-Range Seismic Measurement (LRSM) station KN-UT. To avoid biasing our results with path effects, the record for only one North American station is used for any given event in any given distance interval. Station information for both large and small events is given in Tables V and VIII. We assume that noise and station effects are of secondary importance in controlling coda characteristics, and as such, that it is not necessary to use a common set of station in our analyses. Station effects will be the subject of future investigations.

Grouping the data by distance interval, the large- and small-event codas were analyzed to yield average coda determinations and 95% confidence intervals for the average coda determinations (Appendix I). The codas analyzed were each required to have 8 or more coda observations.

To determine quantitatively the difference in coda levels for the two sets of determinations, the average difference for each distance interval and an associated t-statistic for this difference were computed as follows:

TABLE III

Large Event Information 103-118° Distance

(Listed by Event)

DATE	ORIGIN TIME Hr Min Sec	LATITUDE (Degrees)	LONGITUDE (Degrees)	DEPTH (km)	NOS m_b	NOS M_s	SEC m_b	SEC m_b SOURCE	AREA LOCATION
06 Jul 64	07:22:11.7	18.3N	100.0W	100	6.3		(7.25-7.5 (7.25-7.5 (6.75-7	PAL) BRK) PAS)	Mexico
17 Nov 64	08:15:39.3	5.7S	150.7E	45	6.7				New Britain
14 Mar 65	15:53:06.6	36.3N	70.7E	219	6.6		(7.5 -7.75 (7.75	PAS) BRK)	Hindu Kush
28 Mar 65	16:33:14.6	32.4S	71.2W	61	6.4		(7 -7.25	PAS)	Near Coast Central Chile
29 Apr 65	15:28:43.3	47.4N	122.4W	57	6.5		(7.25 (6.75-7.0 (6.6	PAL) BRK) PAS)	Washington, U. S.
23 Aug 65	19:46:02.9	16.3N	95.8W	28	6.7		(7.5 -7.75 (7.25 (	BRK) PAS) AAL)	Mexico
21 Dec 67	02:25:21.6	21.8S	70.0W	33	6.3		(7.0 (7 -7.3	PAS) BRK)	Near Coast of Northern Chile
28 Nov 68	13:27:18.7	2.9S	139.3E	65	6.1		(7.0 (7 -7.5	PAS) BRK)	New Gu[illegible]
01 Aug 68	20:[illegible]2:21.9	16.5N	12[illegible].2E	37	5.9	7.3			Luzon, Philippines
14 Aug 68	22:14:19.4	[illegible]N	119.8E	23	6.0	7.4			Celebes
4 Jan 70	17:00:40.2	24.1N	[illegible]02.5E	31	5.9	7.5	(7.5	PAS)	Yunan, China
8 Jan 70	17:12:39.1	34.7S	178.6E	179	6.1		(7.0	PAS)	South of Kermadec Islands
10 Jan 70	12:07:08.6	6.8N	126.7E	73	6.1		(7.3	PAS)	Mindanao, Philippines
28 Mar 70	21:02:23.4	39.2N	29.5E	20	6.0	7.1	(7.3	ATH)	Turkey
07 Apr 70	05:34:05.6	15.8N	121.7E	37	6.4	7.3	(7.5	PAS)	Luzon, Philippines
12 Apr 70	[illegible]4:01:44.0	15.1N	122.1E	24	5.9	7.0	(7.0	PAS)	Luzon, Philippines
29 Apr 70	14:01:32.8	14.5N	92.6E	33	5.8	7.3	(7.0	PAS)	Near Coast of Chiapas Mexico
11 Aug 70	10:22:20.0	14.1S	166.7E	33	6.3	7.0	(7.5	BRK)	New Hebrides
31 Oct 70	17:53:09.3	4.9S	145.5E	42	6.0	7.0	(7.0	PAS)	New Guinea
02 Dec 70	15:54:19.9	11.0S	163.3E	33	5.8	7.0	(6.6	BRK)	Solomon Islands
10 Jan 71	07:17:03.7	3.1S	139.7E	33	7.3	8.1	(7.9	BRK)	New Guinea
08 Feb 71	21:04:21.8	63.5S	61.2W	33	6.3	7.0	(7.0	PAS)	South Shetland Islands
09 Jul 71	03:03:18.7	32.5S	71.2W	58	6.6		(7.5	PAS)	Near Coast of Central Chile
14 Jul 71	06:11:29.1	5.5S	153.9E	47		7.9	(7.8	BRK)	New Ireland
19 Jul 71	00:14:45.3	5.7S	153.8E	42	5.8	7.1	(6.5	PAS)	New Ireland
21 Nov 71	05:57:11.9	11.8S	166.5E	115	6.4		(7.1	PAS)	Santa Cruz Islands

DATE	ADE	CNC	COL	COP	CPO	IST	BON	LAO	MAL	NAT	PEL	PRE	SHI	TFO	UBO	WMO
06 Jul 64						104.5°										
17 Nov 64						117.3°										
14 Mar 65					104.9°											
28 Mar 65	10 .2°	105.3°				117.6°	113.1°									
29 Apr 65													103.0°			
23 Aug 65										106.7°						
21 Dec 67	117.2°					110.6°	103.5°									
28 Nov 68														107.6°		117.7°
01 Aug 68								103.4°							105.7°	115.0°
14 Aug 68									116.7°							
4 Jan 70														113.5°		
8 Jan 70			103.0°									113.5°				
10 Jan 70														111.7°		
28 Mar 70											117.3°					
07 Apr 70														109.2°		
12 Apr 70														109.3°		
29 Apr 70										110.1°						
11 Aug 70													117.7°			
31 Oct 70														103.7°		
02 Dec 70													113.3°			
10 Jan 71				112.7°										107.4°		
08 Feb 71														105.4°		
09 Jul 71				112.9°												
14 Jul 71													103.0°			
19 Jul 71													103.0°			
21 Nov 71													116.5°			

ATH: Athens, Greece
BRK: Berkeley, California
PAL: Palisades, New York
PAS: Pasadena, California

TABLE IV

Large Event Information, 103-118° Distance
(Listed by Distance Interval)

DATE	ORIGIN TIME Hr Min Sec	LATITUDE (Degrees)	LONGITUDE (Degrees)	DEPTH (km)	NOS m_b	STATION	DISTANCE	SOURCE REGION
103-105°								
** 6 Jul 64	07:22:11.7	18.3N	100.4W	100	6.3	IST	104.5°	Mexico
14 Mar 65	15:53:06.6	36.3N	70.7E	219	6.6	CPO	104.9°	Hindu Kush
**29 Apr 65	15:28:43.3	47.4N	122.4W	57	6.5	SHI	103.0°	Washington, U. S.
**21 Dec 67	02:25:21.6	21.8S	70.0W	33	6.3	KON	103.5°	Near Coast of Northern Chile
1 Aug 68	20:19:21.9	16.5N	122.2E	37	5.9	LAO	103.4°	Luzon, Philippines
* 8 Jan 70	17:12:39.1	34.7S	178.6E	179	6.1	COL	103.0°	South of Kermadec Islands
* 31 Oct 70	17:53:09.3	4.9S	145.5E	42	6.0	TFO	103.7°	New Guinea
* 14 Jul 71	[illegible]:11:29.1	5.5S	153.9E	47	-	SHI	103.0°	New Ireland
* 19 Jul 71	00:14:45.3	5.7S	153.8E	42	5.8	SHI	103.0°	New Ireland
105-110°								
**28 Mar 65	16:33:14.6	32.4S	71.2W	61	6.4	ADE	107.2°	Near Coast of Central Chile
**28 Mar 65	16:33:14.6	32.4S	71.2W	61	6.4	CMC	105.3°	Near Coast of Central Chile
**23 Aug 65	19:46:02.9	16.3N	95.8W	28	6.7	MAT	106.7°	Mexico
28 May 68	13:27:18.7	2.9S	139.3E	65	6.1	TFO	107.6°	New Guinea
1 Aug 68	20:19:21.9	16.5N	122.2E	37	5.9	UBO	105.7°	Luzon, Philippines
* 7 Apr 70	05:34:05.6	15.8N	121.7E	37	6.4	TFO	109.2°	Luzon, Philippines
* 12 Apr 70	04:01:44.0	15.1N	122.1E	24	5.9	TFO	109.3°	Luzon, Philippines
* 10 Jan 71	07:17:03.7	3.1S	139.7E	33	7.3	TFO	107.4°	New Guinea
* 8 Feb 71	21:04:21.8	63.5S	61.2W	33	6.3	TFO	105.4°	South Shetland Islands
110-115°								
**28 Mar 65	16:33:14.6	32.4S	71.2W	61	6.4	KON	113.1°	Near Coast of Central Chile
**21 Dec 67	02:25:21.6	21.8S	70.0W	33	6.3	IST	110.6°	Near Coast of Northern Chile
* 4 Jan 70	17:00:40.2	24.1N	102.5E	31	5.9	TFO	113.5°	Yunan, China
* 8 Jan 70	17:12:39.1	34.7S	178.6E	179	6.1	PRE	113.5°	South of Kermadec Islands
* 10 Jan 70	12:07:08.6	6.8N	126.7E	73	6.1	TFO	111.7°	Mindanao, Philippines
* 29 Apr 70	14:01:32.8	14.5N	92.6W	33	5.8	MAT	110.1°	Near Coast of Chiapas, Mexico
* 2 Dec 70	15:54:19.9	11.0S	163.3E	37	5.8	SHI	113.3°	Solomon Islands
* 10 Jan 71	07:17:03.7	3.1S	139.7E	33	7.3	COP	112.7°	New Guinea
* 9 Jul 71	03:03:18.7	32.5S	71.2W	58	6.6	COP	112.9°	Near Coast of Central Chile
115-118°								
**17 Nov 64	08:15:39.3	5.7S	150.7E	45	6.7	IST	117.3°	New Britain
**28 Mar 65	16:33:14.6	32.4S	71.2W	61	6.4	IST	117.6°	Near Coast of Central Chile
**21 Dec 67	02:25:21.6	21.8S	70.0W	33	6.3	ADE	117.2°	Near Coast of Northern Chile
28 May 68	13:27:18.7	2.9S	139.3E	65	6.1	WMO	117.7°	New Guinea
1 Aug 68	20:19:21.9	16.5N	122.2E	37	5.9	WMO	115.8°	Luzon, Philippines
**14 Aug 68	22:14:19.4	0.2N	119.8E	23	6.0	MAL	116.7°	Celebes
* 28 Mar 70	21:02:23.4	39.2N	29.5E	20	6.0	PEL	117.3°	Turkey
* 11 Aug 70	10:22:20.0	14.1S	166.7E	33	6.2	SHI	117.7°	New Hebrides
* 21 Nov 71	05:57:11.9	11.8S	166.6E	115	6.4	SHI	116.5°	Santa Cruz Islands

* Arrivals from Sweetser et al. (1973)

** Arrivals from Cohen et al. (1972)

TABLE V

Station Information - Large Events

STATION	LOCATION	LATITUDE (Deg	Min	Sec)	LONGITUDE (Deg	Min	Sec)	ELEVATION Meters
ADE	Adelaide, Australia	34	58	01S	138	42	32E	655
CMC	Copper Mine, N.W.T., Canada	67	50	00N	115	05	00W	31
COL	College Outpost, Alaska	64	54	00N	147	47	30W	320
COP	Copenhagen, Denmark	55	41	00N	12	26	00E	13
CPO	Cumberland Plateau, Tennessee	35	35	41N	85	34	14W	574
IST	Istanbul, Turkey	41	02	44N	28	59	45E	50
KON	Kongsberg, Norway	59	38	57N	9	37	55E	200
LAO	LASA Array Center, Montana	46	41	19N	106	13	20W	744
MAL	Malaga, Spain	36	43	39N	4	24	40W	60
MAT	Matsushiro, Honshu, Japan	36	32	30N	138	12	32E	440
PEL	Peldehue, Chile	33	08	37S	70	41	07W	690
PRE	Pretoria, South Africa	25	45	12S	28	11	24E	1333
SHI	Shiraz, Iran	29	38	18N	52	31	12E	1596
TFO	Tonto Forest, Arizona	34	16	04N	111	16	13W	1609
UBO	Uinta Basin, Utah	40	19	18N	109	34	07W	1596
WMO	Wichita Mountain, Oklahoma	34	43	05N	98	35	21W	505

TABLE VI

Small Event Information, 103-118° Distance
(Listed by Event)

DATE	ORIGIN TIME Hr Min Sec	LATITUDE (Degrees)	LONGITUDE (Degrees)	DEPTH (km)	NOS m_b	NOS M_s	SEC m_b	SEC m_b SOURCE	AREA LOCATION	ADE	CPO	KBL	KN-UT	LAO	LF2	NDI	TFO	UBO	WMO
17 May 63	06:09:18.2	15.7N	120.1E	80	5.5				Luzon, Philippines									107.5°	
20 May 64	06:01:14.8	2.7S	139.3E	61	5.8				New Guinea									107.8°	117.6°
10 Aug 66	05:01:09.4	20.1S	175.3W	96	5.8				Fiji Islands							114.3°			
28 Aug 66	07:29:34.7	35.8S	178.5E	94	5.8				Off Northern New Zealand		114.0°				106.0°				104.4°
11 Jan 67	11:20:45.7	34.1N	45.7E	34	5.6				Iran-Iraq Border	110.8°									
25 Feb 67	11:20:50.1	0.1S	123.9E	92	5.8				Celebes					116.1°					
25 Feb 67	11:38:44.4	0.2S	123.9E	86	5.6				Celebes					116.2°					
20 Apr 67	00:01:26.8	5.5S	129.7E	181	5.7				Banda Sea								116.3°		
1 Nov 67	18:56:54.8	4.8S	135.7E	14	5.8		5.8 -6.2	BRK	New Guinea					112.5°					
13 Feb 68	02:12:31.5	5.5S	131.1E	67	5.8				Banda Sea					116.0°					
26 Jun 68	15:40:31.1	22.2S	171.4E	90	5.6				Loyalty Islands			112.1°							
24 Oct 68	15:51:18.5	5.9N	127.0E	70	5.4		6.50	PAS	Halmahera				109.7°						
7 Dec 68	04:57:49.0	3.4S	145.9E	15	5.3	6.5	6.20	PAS	New Guinea									103.3°	
31 Jan 69	00:44:13.3	4.2N	128.1E	33	5.7	6.3	6.60	PAS	Halmahera									111.1°	
17 Feb 69	00:42:59.2	3.4N	128.4E	14	5.6	6.5	6.50	PAS	Halmahera								112.3°		
20 Feb 69	09:55:33.8	3.5N	128.2E	33	5.7	6.4	6.50	PAS	Halmahera					110.7°					
24 Feb 69	00:08:45.6	6.2S	131.0E	38	5.8	5.9			Tanimbar Island					116.5°					
15 Apr 70	13:14:21.4	15.1N	122.7E	12	5.7	6.0	6.00	PAS	Luzon, Philippines								109.0°		
12 Jun 70	08:06:16.6	2.9S	139.1E	32	5.7	6.1	6.40	PAS	Luzon, Philippines								107.8°		
30 Jul 70	00:52:19.5	37.8N	55.9E	19	5.7	6.6	6.75	BRK	Iran-USSR Border								107.1°		
23 Mar 71	09:52:12.3	41.5N	79.3E	33	5.7		6.80	UPP	Kirgiz-Sinkiang Border								103.8°		
1 Jul 71	01:16:16.8	6.4S	130.3E	133	5.8				Banda Sea						117.9°				
26 Sep 71	16:33:04.7	0.1S	124.9E	71	5.8				Molucca Sea								117.4°		
18 Jan 72	21:15:15.5	4.8S	145.0E	33	5.7	6.6	6.70	BRK	New Guinea					106.3°			104.0°		
19 Jan 72	15:00:54.2	4.7S	145.0E	33	5.8	6.4	6.50	PAS	New Guinea								104.0°		
22 May 72	06:04:00.1	16.5N	122.3E	34	5.7	6.9	6.70	PAS	Luzon, Philippines					103.3°			108.1°		

TABLE VII

Small-Event Information, 103-118° Distance
(Listed by Distance Interval)

DATE	ORIGIN TIME Hr Min Sec	LATITUDE (Degrees)	LONGITUDE (Degrees)	DEPTH (km)	NOS m_b	STATION	DISTANCE	SOURCE REGION
103-105°								
28 Aug 66	07:29:34.7	35.8S	178.5E	94	5.8	WMO	104.4°	Off Northern New Zealand
7 Dec 68	04:57:49.0	3.4S	145.9E	15	5.3	UBO	103.3°	New Guinea
23 Mar 71	09:52:12.3	41.5N	79.3E	33	5.7	TFO	103.8°	Kirgiz-Sinkiana Border
18 Jan 72	21 15:15.5	4.8S	145.0E	33	5.7	TFO	104.0°	New Guinea
19 Jan 72	15:00:54.2	4.7S	145.0E	33	5.9	TFO	104.0°	New Guinea
22 May 72	06:04:00.1	16.6N	122.3E	34	5.7	LAO	103.3°	Luzon, Philippines
105-110°								
17 May 63	05:09:18.2	15.7N	120.1E	80	5.5	UBO	107.5°	Luzon, Philippines
20 May 64	06:01:14.8	2.7S	139.3E	61	5.8	UBO	107.8°	New Guinea
24 Oct 68	15:51:18.5	5.9N	127.0E	70	5.4	KN-UT	109.7°	Halmahera
15 Apr 70	13:14:21.4	15.1N	122.7E	12	5.7	TFO	109.9°	Luzon, Philippines
12 Jun 70	08:06:16.6	2.9S	139.1E	32	5.7	TFO	107.8°	Luzon, Philippines
30 Jul 70	00:52:19.5	37.8N	55.9E	19	5.7	TFO	107.1°	Iran-USSR Border
18 Jan 72	21:15:15.5	4.8S	145.0E	33	5.7	LAO	106.3°	New Guinea
22 May 72	06:04:00.1	16.6N	122.3E	34	5.7	TFO	108.1°	Luzon, Philippines
110-115°								
*10 Aug 66	05:01:09.4	20.1S	175.3W	96	5.8	NDI	114.3°	Fiji Islands
28 Aug 66	07:29:34.7	35.8S	178.5E	94	5.8	CPO	114.0°	Off Northern New Zealand
*11 Jan 67	11:20:45.7	34.1N	45.7E	34	5.6	ADE	110.8°	Iran-Iraq Border
1 Nov 67	18:56:54.8	4.8S	135.7E	14	5.8	LAO	112.5°	New Guinea
*26 Jun 68	15:40:31.1	22.2S	171.4E	90	5.6	KBE	112.1°	Loyalty Islands
31 Jan 69	00:44:13.3	4.2N	128.1E	33	5.7	UBO	111.1°	Halmahera
17 Feb 69	00:42:59.2	3.8N	128.4E	14	5.6	TFO	112.[illegible]°	Halmahera
20 Feb 69	09:55:33.8	3.5N	128.2E	33	5.7	LAO	110.[illegible]	Halmahera
115-118°								
20 May 64	06 01:14.8	2.7S	139.3E	61	5.8	WMO	117.6°	New Guinea
25 Feb 67	11:20:50.1	0.1S	123.9E	92	5.8	LAO	116.1°	Celebes
25 Feb 67	11:33:44.4	0.2S	123.9E	86	5.6	LAO	116.2°	Celebes
20 Apr 67	00:01:26.8	5.5S	129.7E	181	5.7	TFO	116.9°	Banda Sea
13 Feb 68	02:12:31.5	5.5S	131.1E	67	5.8	LAO	116.0°	Banda Sea
24 Feb 69	00:08:45.6	6.2S	131.0E	38	5.8	LAO	116.5°	Tanimbar Island
1 Jul 71	01:16:16.8	6.4S	130.3E	133	5.8	EFZ	117.9°	Banda Sea
26 Sep 71	16:33:04.7	0.1S	124.9E	71	5.8	TFO	117.4°	Molucca Sea

* Arrivals from Sweetser et al. (1973)

TABLE VIII

Station Information - Small Events

STATION	LOCATION	LATITUDE (Deg	Min	Sec)	LONGITUDE (Deg	Min	Sec)	ELEVATION Meters
ADE	Adelaide, Australia	34	58	01S	138	42	32E	655
CPO	Cumberland Plateau, Tennessee	35	35	41N	85	34	14W	574
KBL	Kabul, Afganistan	34	34	00N	69	06	24E	1980
KN-UT	Kanab, Utah	37	01	22N	112	49	39W	1737
LAO	LASA Array Center, Montana	46	41	19N	106	13	20W	744
LF2	LASA Array F-Ring (2), Montana	45	54	34N	105	29	08W	754
NDI	New Delhi, India	28	41	00N	77	13	00E	230
TFO	Tonto Forest, Arizona	34	16	04N	111	16	13W	1609
UBO	Uinta Basin, Utah	40	19	18N	109	34	07W	1596
WMO	Wichita Mountain, Oklahoma	34	43	05N	98	35	21W	505

Let $\overline{X}_i$ be the average small-event coda amplitude at the i'th time point;

m_i be the number of individual coda values at the i'th time point which went into the determination of $\overline{X}_i$;

s_{x_i} be the standard deviation of the individual small-event coda determinations at the i'th time point;

$\overline{Y}_i$ be the average large-event coda amplitude at the i'th time point;

n_i be the number of individual coda values at the i'th time point which went into the determination of $\overline{Y}_i$;

s_{y_i} be the standard deviation of the individual large-event coda determination at the i'th time point.

Then:

$$\delta_i = \overline{Y}_i - \overline{X}_i$$

and

$$\overline{\delta} = P^{-1} \sum_{i=1}^{P} \delta_i$$

where P is the number of time points for which corresponding large event and small event average coda determinations are available.

To compute the associated t-statistic, we must first determine the standard deviation of the mean difference, $s_{\overline{\delta}}$:

$$s_{\overline{\delta}} = \frac{s}{P} \quad \sum_{i=1}^{P} \frac{1}{m_i} + \sum_{i=1}^{P} \frac{1}{n_i} \quad {}^{1/2}$$

where

$$s^2 = \frac{\sum_{i=1}^{P} (m_i - 1\ s_{x_i}^2 + \sum_{i=1}^{P} (n_i - 1\ s_{y_i}^2}{\sum_{i=1}^{P} (m_i - 1) + \sum_{i=1}^{P} (n_i - 1)}.$$

Then:

$$t = \frac{\overline{\delta}}{s_{\overline{\delta}}}.$$

It should be noted that the standard deviations of the mean differences $s_{\bar{\delta}}$ shown by Sweetser et al. (1973, page 42) are incorrect; the correct values for their work are shown in Table IX.

Sweetser et al. (1973), using average coda determinations, found that the greater the event magnitude, the higher is the relative amplitude level at any given time for elapsed times greater than 10-20 seconds into the coda. Specifically, large-event codas were, on the average, about 0.14 m_b units higher in relative amplitude than corresponding relative amplitudes in small event codas. This suggested that large events are multiple events, and the corresponding period of source activity for a large event sequence was estimated visually to be on the order of 1 to 2 minutes.

An analysis of the differences in the large- and small-event codas for the codas shown in Appendix I is given in Table X. Statistically, of the four data sets examined, three show the large-event codas to be significantly larger than the small-event codas at the 95% confidence level (one-sided t-test). Only the 0.17 m_b units difference found in the distance interval 115-118°, however, is in close agreement with the 0.14 m_b units average difference found in our earlier work. That the difference is due probably to the low signal-to-noise ratios observed on the seismograms rather than a real difference in coda behavior. Small events especially in the shadow zone, which are generally recorded with low signal-to-noise ratios, tend to yield high coda determinations throughout the coda relative to the maximum. This biases the average coda determinations for small events upwards, thereby lessening and apparently eliminating, in some cases, the 0.1-0.2 m_b units difference in large- and small-event codas which was observed in our earlier work. A thorough explanation of this effect is given by Sweetser et al. (1973). The signal-to-noise problem is particularly bad in the distance interval 105-110°, where the first arrival is a weak emergent, diffracted P phase (P_{diff}). As shown by Sweetser and Blandford (1973), the amplitude of the P_{diff} in this interval is reduced on the order of 0.7 m_b units over the amplitude of the P phase at distances of about 100° (Figure 1); thus unless an event had a magnitude $m_b \gtrsim 5.6$-5.8, we found it difficult to

TABLE IX

Coda Difference Analysis
(Modified after Sweetser et al., 1973)
(Observations at 0 and 10 Seconds Eliminated)

DISTANCE INTERVAL	AVERAGE DIFFERENCE** IN MEAN CODA, $\bar{\delta}$ (m_b)	STANDARD DEVIATION, $s_{\bar{\delta}}$** (m_b)	t-VALUE	OBSERVATIONAL PAIRS DEG. FREEDOM
42-53°	0.16	0.03	5.90*	460
53-56°	0.02	0.05	0.37	90
56-59°	0.09	0.05	1.88*	87
59-63°	0.25	0.04	6.87*	234
63-67°	0.09	0.03	3.32*	173
67-72°	0.11	0.02	4.82*	312
72-79°	0.13	0.02	6.11*	385
79-84°	0.17	0.03	6.06*	220
84-98°	0.13	0.02	8.25*	682
98-103°	0.03	0.02	1.09	116
110-115°	0.05	0.03	1.87*	69
118-127°	0.08	0.02	3.64*	199
127-136°	-0.11	0.01	-13.72*	165
136-140°	0.19	0.04	4.39*	46
140-145°	-0.11	0.04	-3.00*	47
145-155°	0.28	0.03	8.73*	65
155-166°	0.14	0.02	6.72*	49

*Significant at the 95% confidence level for a one-sided t-test; critical test value is 1.64.

**Values rounded to the nearest hundredth.

TABLE X

Coda Difference Analysis
(Observations at 0 and 10 Seconds Eliminated)

DISTANCE INTERVAL	AVERAGE DIFFERENCE IN MEAN CODA, $\bar{\delta}$** (m_b)	STANDARD DEVIATION, $s_{\bar{\delta}}$** (m_b)	t-VALUE*	OBSERVATIONAL PAIRS DEG. FREEDOM
103-105°	0.04	0.01	8.00	240
105-110°	0.04	0.01	7.87	294
110-115°	-0.02	0.01	-3.33	226
115-118°	0.17	0.01	28.92	251

*Significant at the 95% confidence level for a one-sided t-test; critical test value is 1.64.

**Values rounded to the nearest hundredth.

obtain accurate determinations of P_{diff} coda decay characteristics. Similar problems are encountered for the P arrivals for events at distances between 103-105°, and for the PKIKP arrivals for events at distances between 110° and 112°.

The problem of low signal-to-noise ratios in the range 103-118° is much less pronouned for PP arrivals than for P_{diff} or PKIKP arrivals (Figure 1). We expect, therefore, that a comparison of codas for PP and later phases would bettwe exhibit coda differences between large and small events. That this is true is shown by the results of Table XI. Here all coda determinations prior to the arrival of the PP phase have been omitted, and coda differences computed from the remaining determinations. With one exception (for the interval 110-115°), coda differences of from 0.07 to 0.18 m_b units are now observed. We therefore conclude that a statistically significant difference is observed between large- and small-event codas, and that large-event codas are on the average 0.11 m_b units greater than small-event codas (average of positive differences only).

If large events are multiple events, significant secondary phases should be extended in time. As such, coda decay characteristics for large events should be retarded by arrivals from events which may occur following the initial event in a sequence. This effect is shown in Figures 2 through 4, which shows that the large- and small-event codas can be brought into coincidence by shifting the large event codas to earlier relative times. Estimates for the time shift, on the order of 1 to 2 minutes, can only be given to the nearest minute due to the method used to quantify the coda.

Average Coda Determinations

Two sets of coda determinations will be given, one each for "large" and "small" events.

For small events, average P and PKIKP codas (solid line), together with their corresponding standard deviations for the individual coda observations (dashed lines) are given in Appendix II. Average P and PKIKP codas for large events are shown in Appendix III.

TABLE XI

Coda Difference Analysis

(Observations for PP and later phases)

DISTANCE INTERVAL	TIME INTERVAL OF FIRST READING s - seconds m - minutes	AVERAGE DIFFERENCE** IN MEAN CODA, $\bar{\delta}$ (m_b)	STANDARD DEVIATION, $s_{\bar{\delta}}$** (m_b)	t-VALUE*	OBSERVATIONAL PAIRS DEG. FREEDOM
103-105°	4-5m	0.08	0.01	13.35	136
105-110°	4-5m	0.07	0.01	11.15	166
110-115°	40-50s	-0.02	0.01	-3.08	181
115-118°	1-2m	0.18	0.01	23.84	176

*Significant at the 95% confidence level for a one-sided t-test; critical test value is 1.64.

**Values rounded to the nearest hundredth.

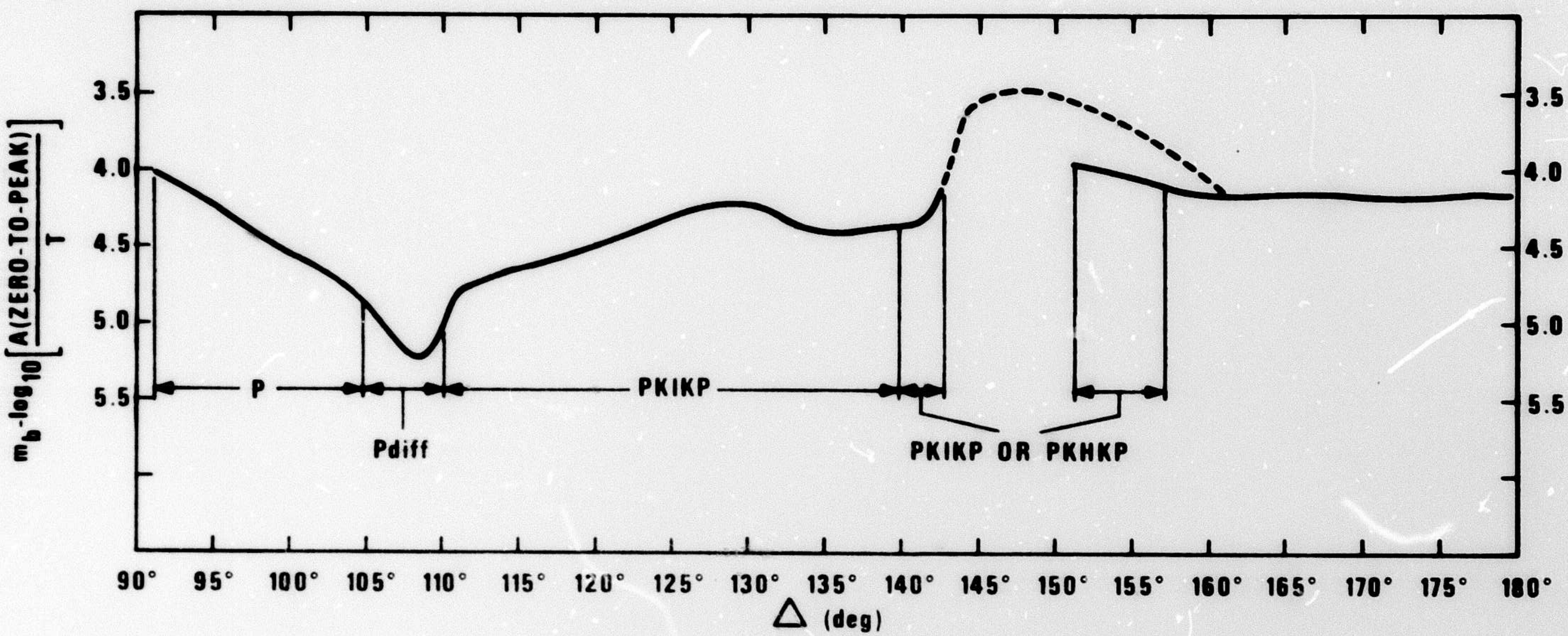

Figure 1. "B" Factor versus distance curves from ISC event data (90°–180°) after Sweetser and Blandford, 1973.

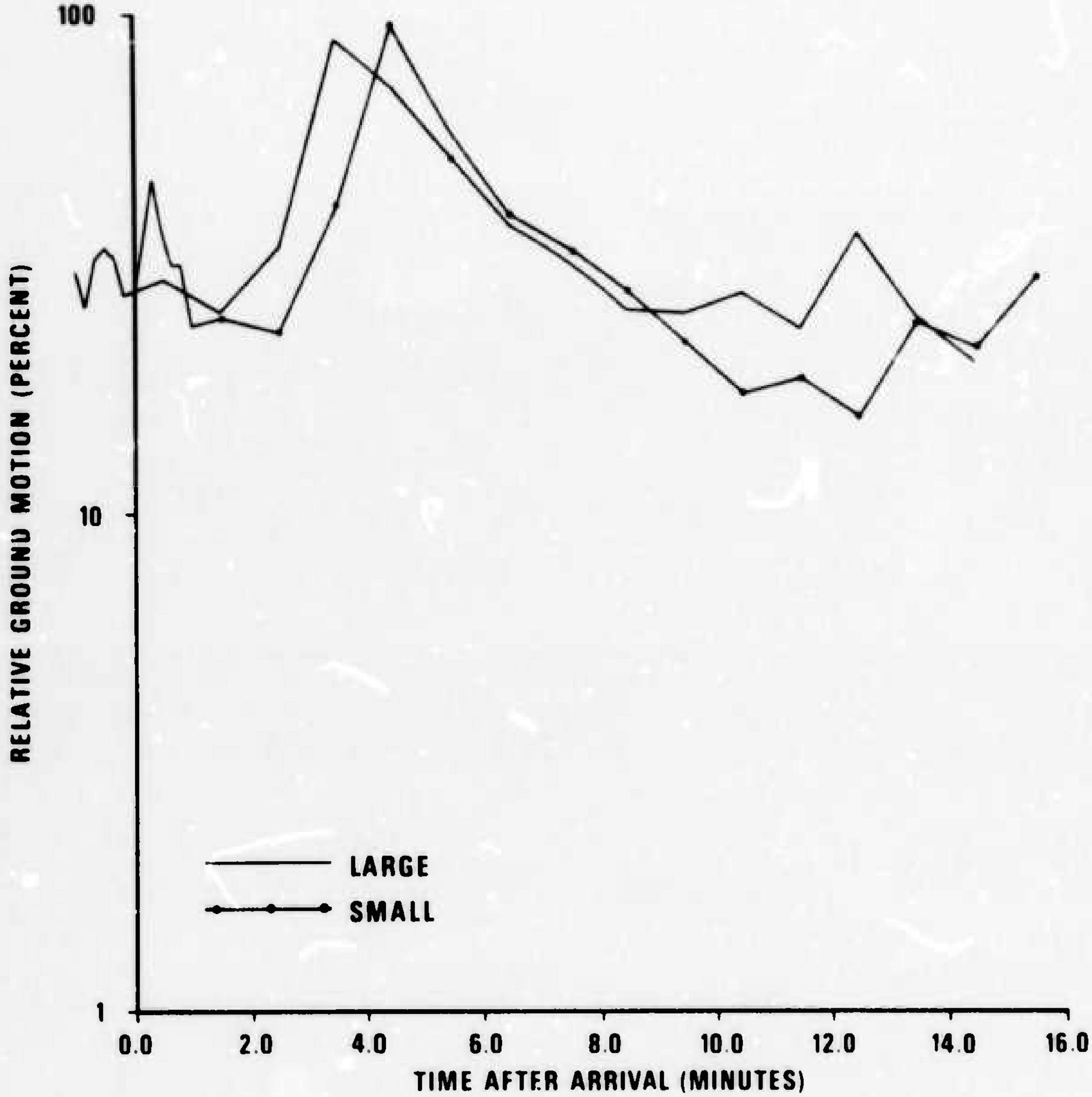

Figure 2. Comparison of large-event and small-event codas, 103°-105° distance, with the large-event coda shifted 1 minute earlier relative to the small-event coda.

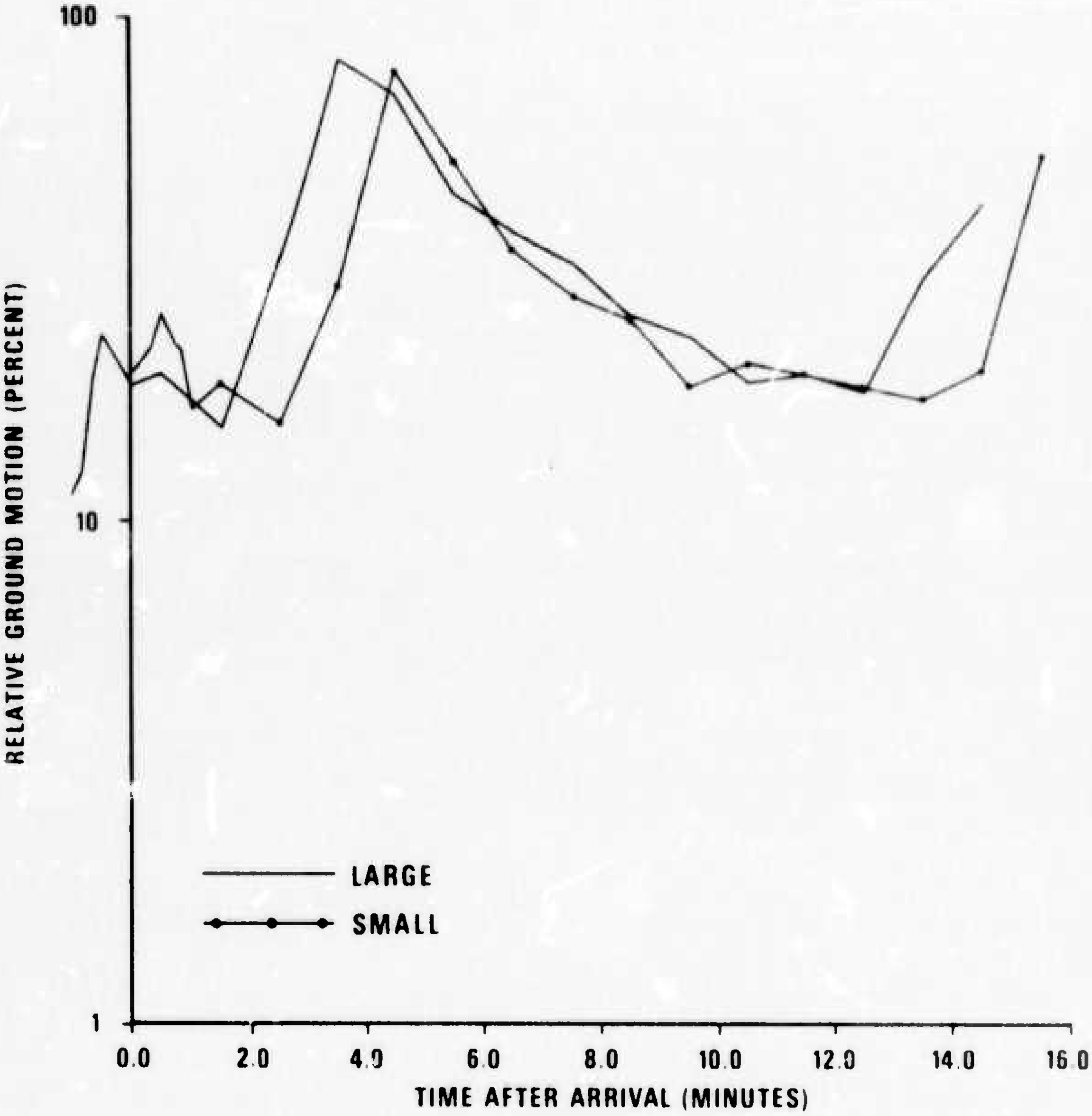

Figure 3. Comparison of large-event and small-event codas, 105°-110° distance, with the large-event coda shifted 1 minute earlier relative to the small-event coda.

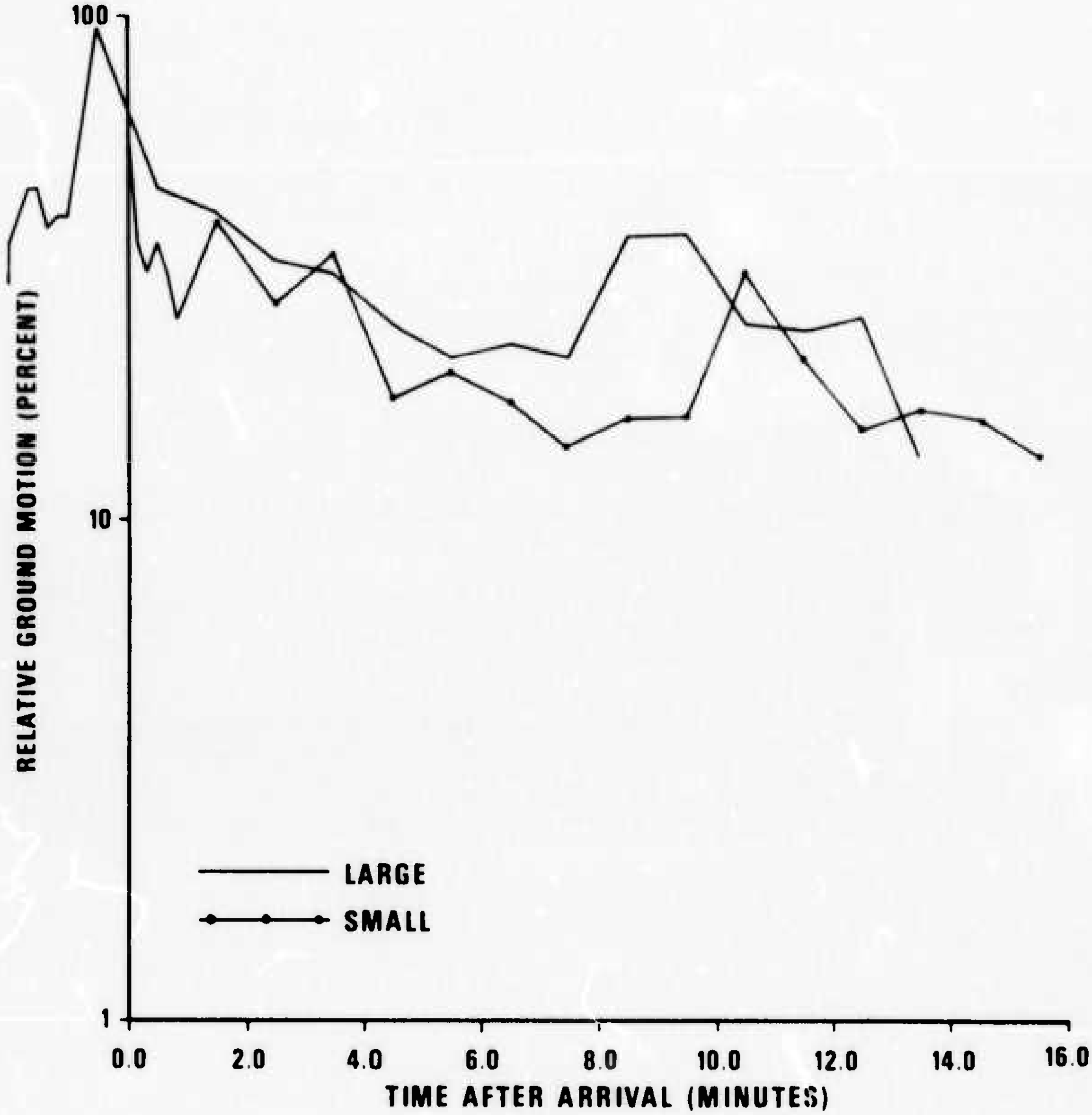

Figure 4. Comparison of large-event and small-event codas, 115°-118° distance, with the large-event coda shifted 2 minutes earlier relative to the small-event coda.

CONCLUSIONS

From an analysis of 26 small-event ($m_b \leq 5.8$) seismograms recorded at a world-wide network of 10 stations, and of 26 large-event (m_b, M_s, or secondary $m_b \geq 7.0$) seismograms recorded at a world-wide network of 16 stations, the following conclusions are drawn with respect to coda-decay characteristics for events in the distance interval 103-118°:

1. The greater the event magnitude, the higher is the relative coda amplitude for times greater than the arrival time for PP. At the 95% confidence level (one-sided t-test), the mean difference is 0.11 m_b units.

2. Differences in relative coda levels for large and small events (though they probably exist) are not well observed for P, P_{diff}, and PKIKP arrivals in the distance intervals 103-105°, 105-110°, 110-115°, respectively. In the distance range 103-115°, these phases, especially those which derive from small events, are generally not well recorded; thus it is difficult to obtain accurate determinations of their relative coda levels.

3. The retarded coda-decay characteristics for large events support the hypothesis that these are multiple events. Further, the period of source activity is estimated at 1 to 2 minutes.

REFERENCES

Cohen, T. J., Sweetser, E. I. and Dutterer, T. J., 1972. P and PKP coda decay characteristics for earthquakes, Seismic Data Laboratory Report No. 301, Teledyne Geotech, Alexandria, Virginia.

Sweetser, E. I. and Blandford, R. R., 1973. Seismic distance-amplitude relations for short period P, P_{diff}, PP and compressional core phases for $\Delta > 90°$, Seismic Data Analysis Center Report SDAC-TR-73-9, Teledyne Geotech, Alexandria, Virginia.

Sweetser, E. I., Cohen, T. J. and Tillman, M. F., 1973. Average P and PKP codas for earthquakes, Seismic Data Laboratory Report No. 305, Teledyne Geotech, Alexandria, Virginia.

APPENDIX I

Comparison of large-event and small-event coda averages; large-event coda average shown in bold black; small-event coda average shown in narrow black; dashed and dashed lines with dots, respectively, indicate 95% confidence level for the coda averages.

1. 103-105°
2. 105-110°
3. 110-115°
4. 115-118°

LARGE-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	31.	0.08	9.
10.0S	27.	0.07	9.
20.0S	33.	0.06	9.
30.0S	35.	0.07	9.
40.0S	33.	0.05	9.
50.0S	28.	0.05	9.
1.0M	29.	0.06	9.
1.5M	30.	0.06	9.
2.5M	26.	0.06	9.
3.5M	35.	0.05	9.
4.5M	90.	0.04	9.
5.5M	71.	0.05	9.
6.5M	53.	0.05	9.
7.5M	38.	0.05	8.
8.5M	32.	0.07	7.
9.5M	26.	0.04	7.
10.5M	26.	0.04	7.
11.5M	28.	0.08	7.
12.5M	24.	0.07	7.
13.5M	37.	0.06	7.
14.5M	25.	0.04	7.
15.5M	20.	0.10	7.

SMALL-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	27.	0.08	6.
10.0S	35.	0.05	6.
20.0S	47.	0.08	6.
30.0S	37.	0.04	6.
40.0S	32.	0.11	6.
50.0S	32.	0.10	6.
1.0M	24.	0.13	6.
1.5M	25.	0.08	6.
2.5M	23.	0.04	6.
3.5M	41.	0.04	6.
4.5M	95.	0.02	6.
5.5M	59.	0.05	6.
6.5M	40.	0.03	6.
7.5M	34.	0.04	6.
8.5M	28.	0.06	6.
9.5M	22.	0.07	6.
10.5M	18.	0.05	6.
11.5M	19.	0.05	6.
12.5M	16.	0.08	6.
13.5M	24.	0.07	5.
14.5M	22.	0.08	5.
15.5M	30.	0.04	5.

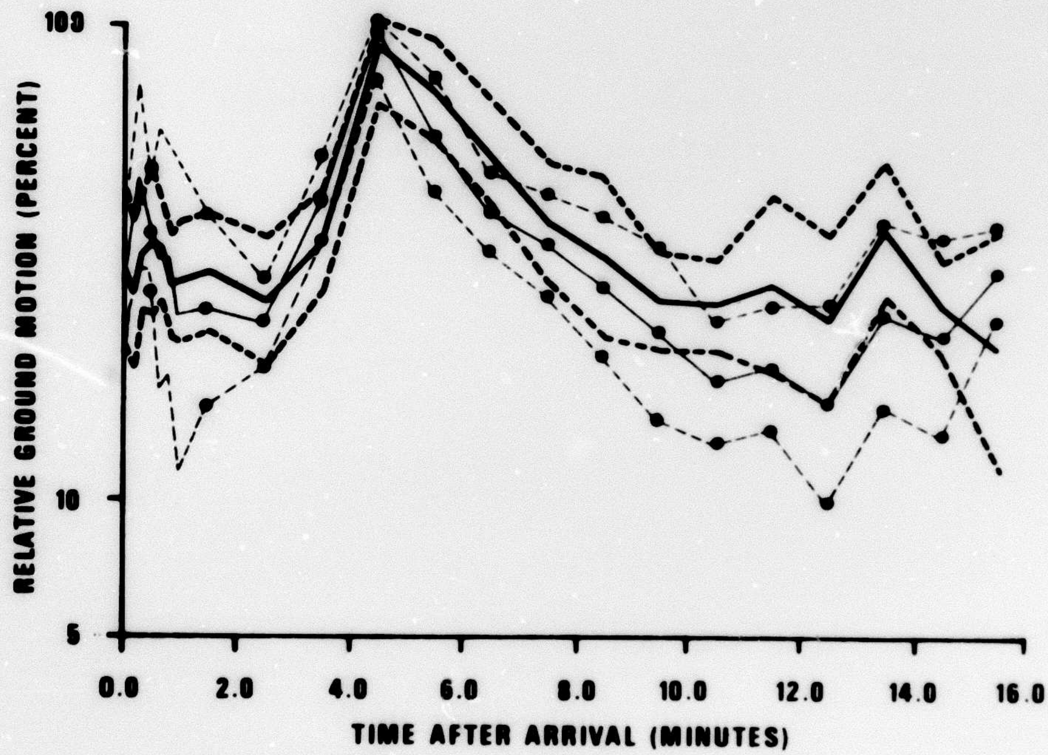

Figure AI-1. Comparison of large-event and small event coda averages, 103-105°.

LARGE-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	12.	0.07	9.
10.0S	13.	0.11	9.
20.0S	20.	0.08	9.
30.0S	24.	0.04	9.
40.0S	22.	0.04	9.
50.0S	21.	0.06	9.
1.0S	19.	0.06	9.
1.5M	20.	0.04	9.
2.5M	16.	0.05	9.
3.5M	34.	0.07	9.
4.5M	83.	0.06	9.
5.5M	71.	0.05	9.
6.5M	45.	0.05	9.
7.5M	38.	0.04	9.
8.5M	33.	0.03	8.
9.5M	26.	0.04	7.
10.5M	24.	0.03	6.
11.5M	19.	0.02	5.
12.5M	20.	0.05	5.
13.5M	19.	0.09	5.
14.5M	31.	0.06	5.
15.5M	43.	0.06	5.

SMALL-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	20.	0.05	9.
10.0S	21.	0.07	9.
20.0S	23.	0.08	9.
30.0S	26.	0.08	9.
40.0S	23.	0.07	9.
50.0S	22.	0.07	9.
1.0M	17.	0.08	9.
1.5M	19.	0.07	9.
2.5M	16.	0.08	9.
3.5M	30.	0.06	9.
4.5M	79.	0.06	9.
5.5M	53.	0.05	9.
6.5M	35.	0.05	9.
7.5M	28.	0.05	9.
8.5M	25.	0.05	9.
9.5M	19.	0.03	9.
10.5M	21.	0.03	9.
11.5M	20.	0.06	9.
12.5M	19.	0.05	9.
13.5M	18.	0.04	9.
14.5M	20.	0.05	9.
15.5M	53.	0.10	9.

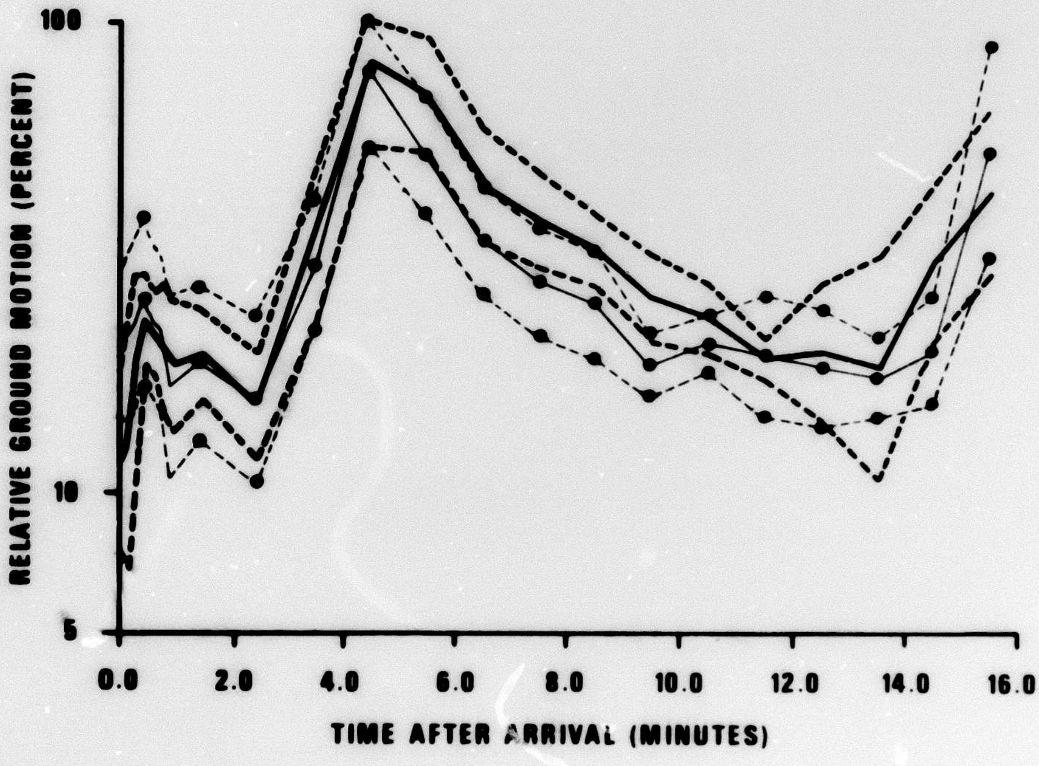

Figure AI-2. Comparison of large-event and small-event coda averages, 105-110°.

LARGE-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	41.	0.04	9.
10.0S	43.	0.05	9.
20.0S	39.	0.06	9.
30.0S	47.	0.05	9.
40.0S	46.	0.06	9.
50.0S	57.	0.04	9.
1.0M	73.	0.04	9.
1.5M	98.	0.01	9.
2.5M	62.	0.04	9.
3.5M	50.	0.04	9.
4.5M	40.	0.06	8.
5.5M	39.	0.08	8.
6.5M	33.	0.09	8.
7.5M	28.	0.05	8.
8.5M	29.	0.06	7.
9.5M	26.	0.09	7.
10.5M	30.	0.07	6.
11.5M	43.	0.10	5.
12.5M	32.	0.07	5.
13.5M	31.	0.09	4.
14.5M	19.	0.11	4.
15.5M	26.	0.03	4.

SMALL-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	83.	0.05	8.
10.0S	52.	0.06	8.
20.0S	51.	0.05	8.
30.0S	41.	0.06	8.
40.0S	44.	0.07	8.
50.0S	55.	0.08	8.
1.0M	48.	0.08	8.
1.5M	52.	0.09	8.
2.5M	44.	0.08	7.
3.5M	48.	0.06	6.
4.5M	33.	0.07	6.
5.5M	37.	0.06	5.
6.5M	44.	0.04	5.
7.5M	32.	0.07	5.
8.5M	29.	0.07	5.
9.5M	28.	0.06	5.
10.5M	42.	0.06	5.
11.5M	50.	0.13	5.
12.5M	39.	0.07	5.
13.5M	45.	0.11	5.
14.5M	38.	0.13	4.
15.5M	40.	0.15	4.

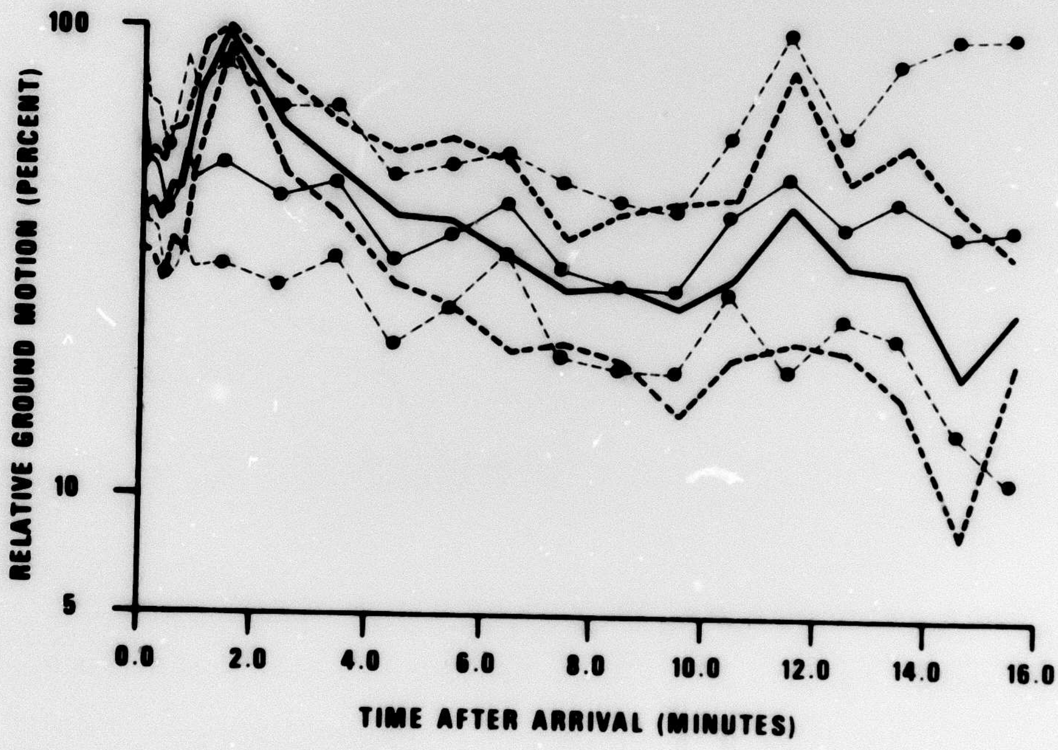

Figure AI-3. Comparison of large-event and small-event coda averages, 110-115°.

LARGE-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	35.	0.11	9.
10.0S	40.	0.07	9.
20.0S	46.	0.06	9.
30.0S	46.	0.07	9.
40.0S	38.	0.06	9.
50.0S	41.	0.04	9.
1.0M	40.	0.02	9.
1.5M	95.	0.02	9.
2.5M	46.	0.06	9.
3.5M	41.	0.05	9.
4.5M	33.	0.05	8.
5.5M	31.	0.05	7.
6.5M	25.	0.07	7.
7.5M	21.	0.10	7.
8.5M	23.	0.12	6.
9.5M	21.	0.13	6.
10.5M	37.	0.10	6.
11.5M	37.	0.08	6.
12.5M	25.	0.12	6.
13.5M	24.	0.14	5.
14.5M	26.	0.16	5.
15.5M	14.	0.10	4.

SMALL-EVENT CODA

TIME	AVG	STD DEV	OBS
0.0S	70.	0.11	8
10.0S	36.	0.11	8.
20.0S	31.	0.05	8.
30.0S	36.	0.04	8.
40.0S	31.	0.07	8.
50.0S	25.	0.07	8.
1.0M	28.	0.06	8.
1.5M	40.	0.07	8.
2.5M	27.	0.05	8.
3.5M	34.	0.12	8.
4.5M	18.	0.06	8.
5.5M	20.	0.06	7.
6.5M	18.	0.06	7.
7.5M	14.	0.06	7.
8.5M	16.	0.07	7.
9.5M	16.	0.07	7.
10.5M	31.	0.11	7.
11.5M	21.	0.06	7.
12.5M	15.	0.06	7.
13.5M	17.	0.07	6.
14.5M	16.	0.07	6.
15.5M	14.	0.05	6.

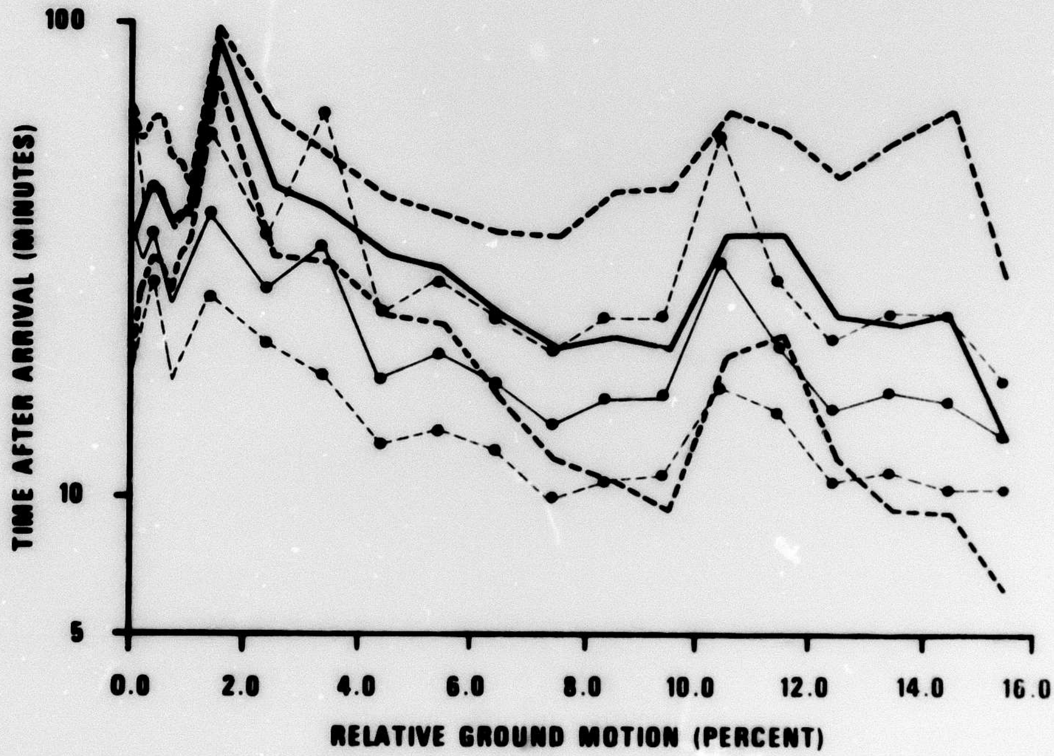

Figure AI-4. Comparison of large-event and small-event coda averages, 115-118°.

APPENDIX II

Small-event coda averages; dashed lines with dots indicate ± one standard of the individual coda observations.

1. 103-105°
2. 105-110°
3. 110-115°
4. 115-118°

TIME	AVG	STD DEV	OBS
0.0S	27.	0.20	6.
10.0S	35.	0.13	6.
20.0S	47.	0.18	6.
30.0S	37.	0.09	6.
40.0S	32.	0.26	6.
50.0S	32.	0.24	6.
1.0M	24.	0.32	6.
1.5M	25.	0.20	6.
2.5M	23.	0.09	6.
3.5M	41.	0.09	6.
4.5M	95.	0.06	6.
5.5M	59.	0.12	6.
6.5M	40.	0.08	6.
7.5M	34.	0.10	6.
8.5M	28.	0.14	6.
9.5M	22.	0.18	6.
10.5M	18.	0.12	6.
11.5M	19.	0.12	6.
12.5M	16.	0.20	6.
13.5M	24.	0.16	5.
14.5M	22.	0.17	5.
15.5M	30.	0.08	5.

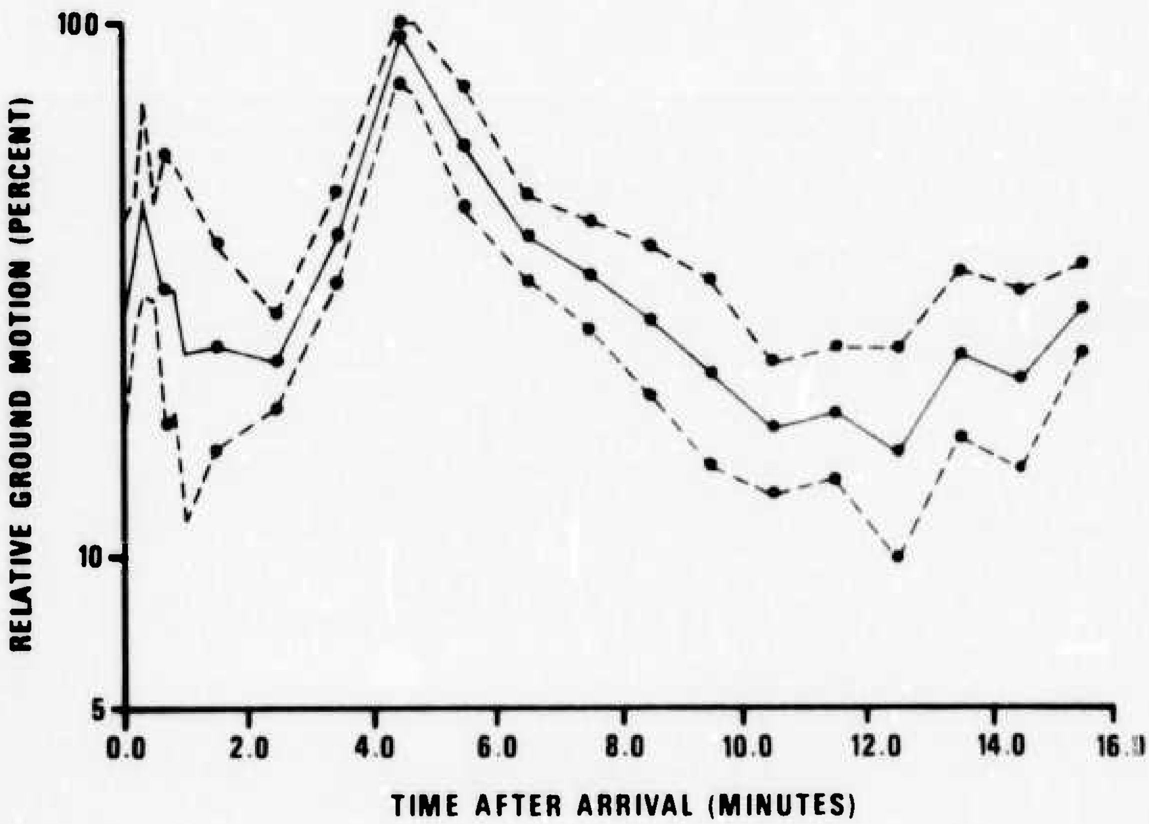

Figure AII-1. Small-event coda averages, 103-105°.

TIME	AVG	STD DEV	OBS
0.0S	20.	0.14	9.
10.0S	21.	0.22	9.
20.0S	23.	0.24	9.
30.0S	26.	0.23	9.
40.0S	23.	0.21	9.
50.0S	22.	0.21	9.
1.0M	17.	0.25	9.
1.5M	19.	0.21	9.
2.5M	16.	0.23	9.
3.5M	30.	0.18	9.
4.5M	79.	0.17	9.
5.5M	53.	0.16	9.
6.5M	35.	0.15	9.
7.5M	28.	0.15	9.
8.5M	25.	0.15	9.
9.5M	19.	0.09	9.
10.5M	21.	0.08	9.
11.5M	20.	0.17	9.
12.5M	19.	0.16	9.
13.5M	18.	0.11	9.
14.5M	20.	0.15	9.
15.5M	53.	0.29	9.

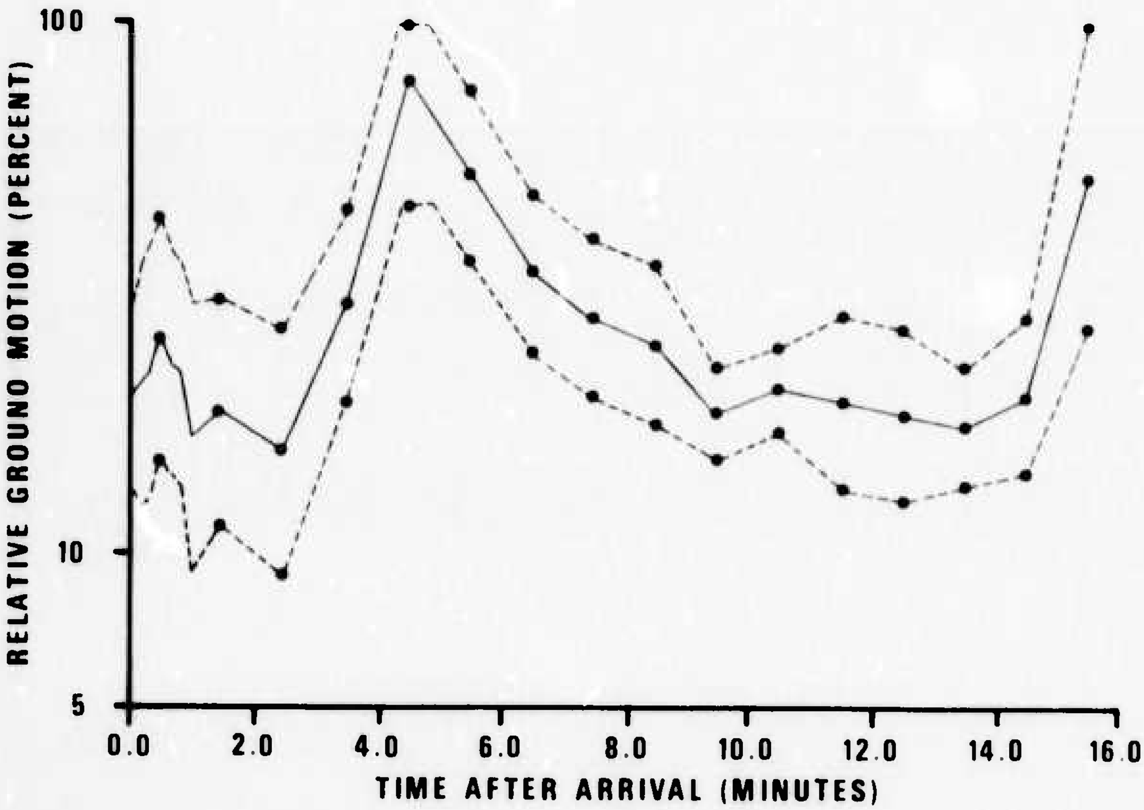

Figure AII-2. Small-event coda averages, 105-110°.

TIME	AVG	STD DEV	OBS
0.0S	83.	0.14	8.
10.0S	52.	0.16	8.
20.0S	51.	0.15	8.
30.0S	41.	0.16	8.
40.0S	44.	0.19	8.
50.0S	55.	0.24	8.
1.0M	48.	0.23	8.
1.5M	52.	0.26	8.
2.5M	44.	0.20	7.
3.5M	48.	0.15	6.
4.5M	33.	0.17	6.
5.5M	37.	0.12	5.
6.5M	44.	0.09	5.
7.5M	32.	0.15	5.
8.5M	29.	0.15	5.
9.5M	28.	0.14	5.
10.5M	42.	0.13	5.
11.5M	50.	0.29	5.
12.5M	39.	0.16	5.
13.5M	45.	0.24	5.
14.5M	38.	0.26	4.
15.5M	40.	0.30	4.

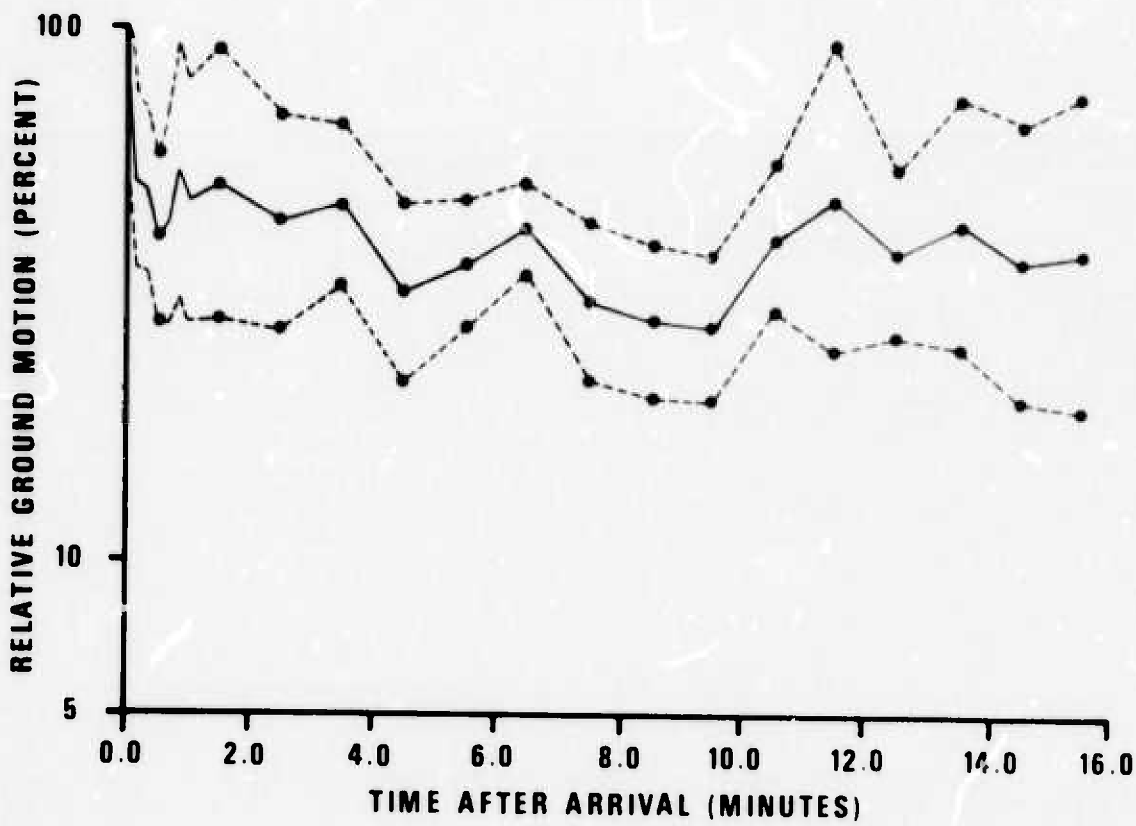

Figure AII-3. Small-event coda averages, 110-115°.

TIME	AVG	STD DEV	OBS
0.0S	70.	0.30	8.
10.0S	36.	0.32	8.
20.0S	31.	0.15	8.
30.0S	36.	0.22	8.
40.0S	31.	0.19	8.
50.0S	25.	0.19	8.
1.0M	28.	0.16	8.
1.5M	40.	0.21	8.
2.5M	27.	0.14	8.
3.5M	34.	0.33	8.
4.5M	18.	0.17	8.
5.5M	20.	0.17	7.
6.5M	18.	0.15	7.
7.5M	14.	0.17	7.
8.5M	16.	0.19	7.
9.5M	16.	0.18	7.
10.5M	31.	0.29	7.
11.5M	21.	0.15	7.
12.5M	15.	0.16	7.
13.5M	17.	0.16	6.
14.5M	16.	0.18	6.
15.5M	14.	0.11	6.

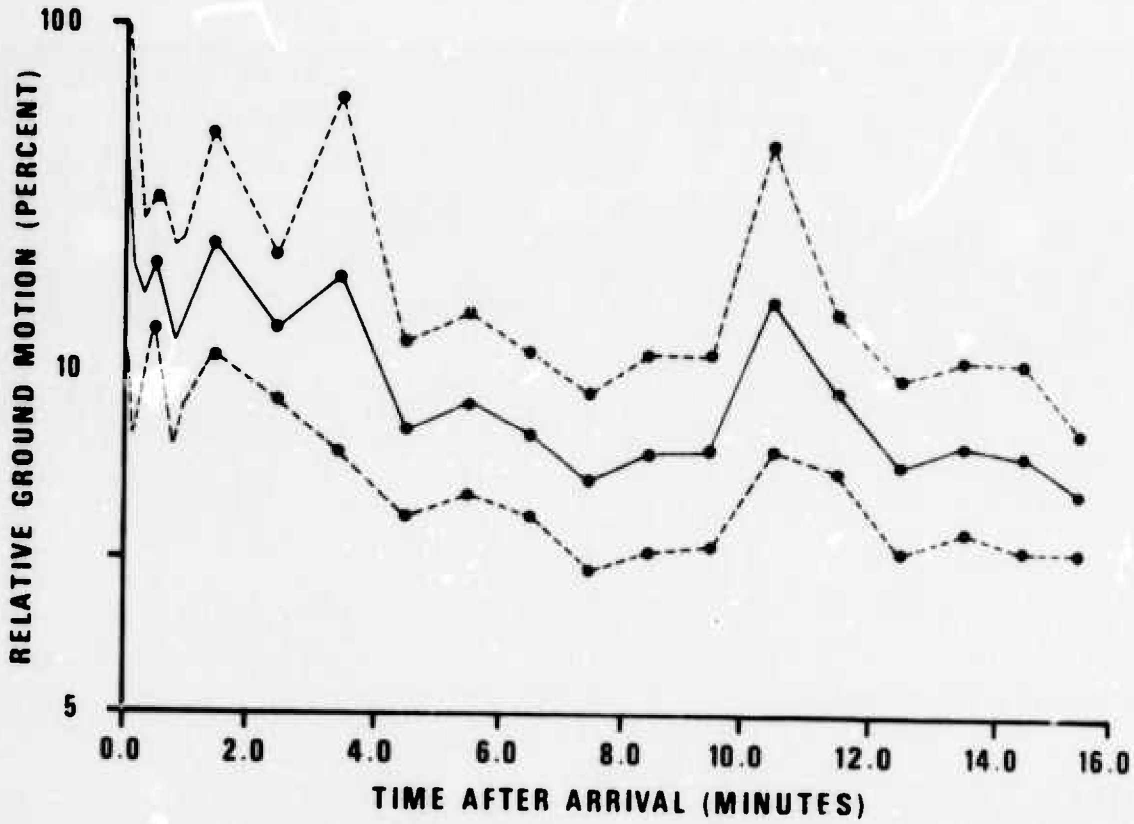

Figure AII-4. Small-event coda averages, 115-118°.

APPENDIX III

Large-event coda averages; dashed lines indicate ± one standard deviation of the individual coda observations.

1. 103-105°
2. 105-110°
3. 110-115°
4. 115-118°

TIME	AVG	STD DEV	OBS
0.0S	31.	0.23	9.
10.0S	27.	0.21	9.
20.0S	33.	0.17	9.
30.0S	35.	0.20	9.
40.0S	33.	0.14	9.
.0.0S	28.	0.14	9.
1.0M	29.	0.17	9.
1.5M	30.	0.17	9.
2.5M	26.	0.18	9.
3.5M	35.	0.14	9.
4.5M	90.	0.12	9.
5.5M	71.	0.14	9.
6.5M	53.	0.14	9.
7.5M	38.	0.15	8.
8.5M	32.	0.18	7.
9.5M	26.	0.11	7.
10.5M	26.	0.10	7.
11.5M	28.	0.20	7.
12.5M	24.	0.19	7.
13.5M	37.	0.16	7.
14.5M	25.	0.10	7.
15.5M	20.	0.27	7.

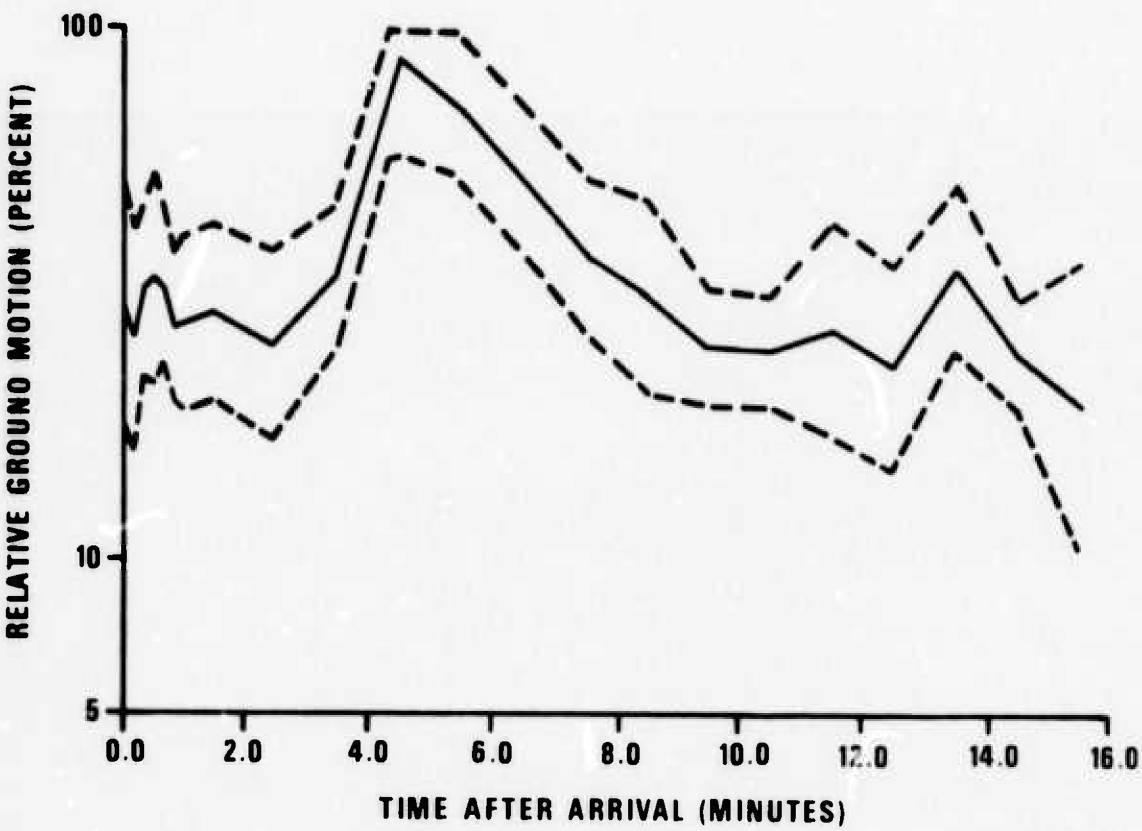

Figure AIII-1. Large-event coda averages, 103-105°.

TIME	AVG	STD DEV	OBS
0.0S	12.	0.20	9.
10.0S	13.	0.34	9.
20.0S	20.	0.24	9.
30.0S	24.	0.12	9.
40.0S	22.	0.12	9.
50.0S	21.	0.18	9.
1.0M	19.	0.18	9.
1.5M	20.	0.12	9.
2.5M	16.	0.15	9.
3.5M	34.	0.22	9.
4.5M	83.	0.17	9.
5.5M	71.	0.15	9.
6.5M	45.	0.16	9.
7.5M	38.	0.13	9.
8.5M	33.	0.09	8.
9.5M	26.	0.10	7.
10.5M	24.	0.07	6.
11.5M	19.	0.04	5.
12.5M	20.	0.12	5.
13.5M	19.	0.19	5.
14.5M	31.	0.13	5.
15.5M	43.	0.14	5.

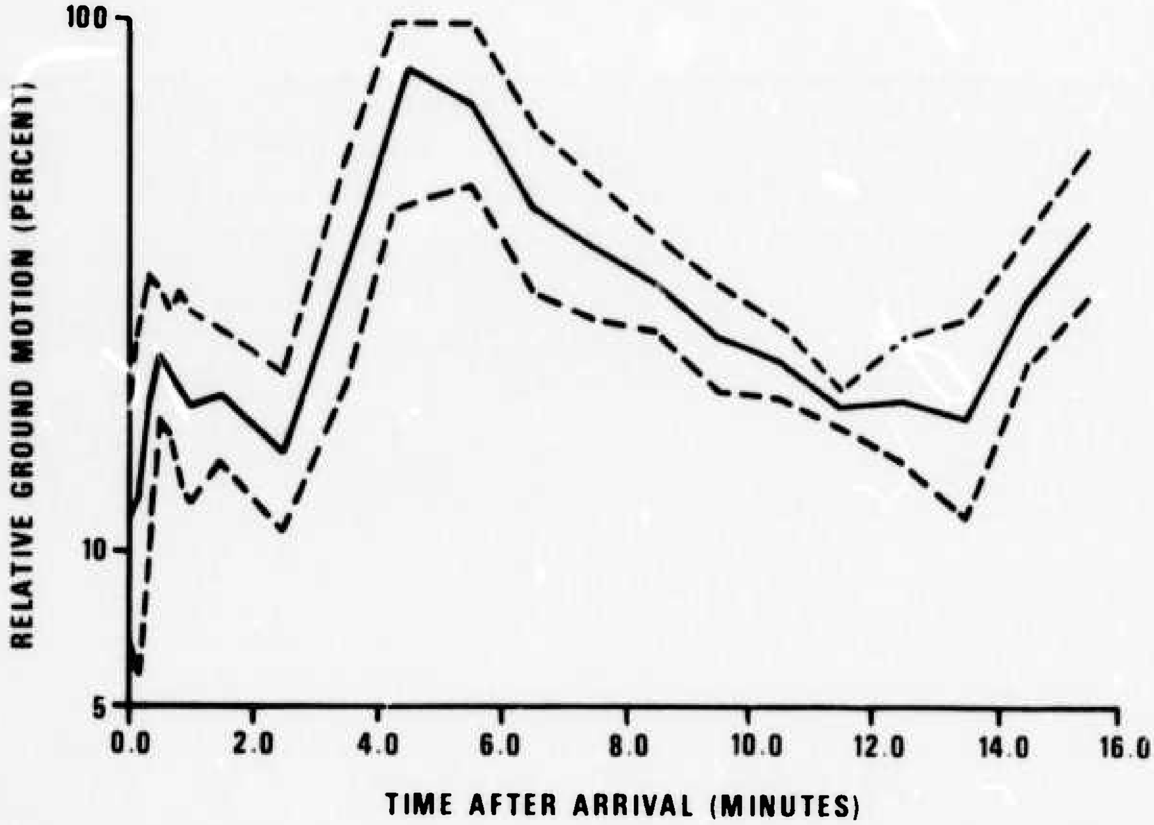

Figure AIII-2. Large-event coda averages, 105-110°.

TIME	AVG	STD DEV	OBS
0.0S	41.	0.11	9.
10.0S	43.	0.15	9.
20.0S	39.	0.17	9.
30.0S	47.	0.15	9.
40.0S	46.	0.18	9.
50.0S	57.	0.12	9.
1.0M	73.	0.13	9.
1.5M	98.	0.03	9.
2.5M	62.	0.13	9.
3.5M	50.	0.13	9.
4.5M	40.	0.16	8.
5.5M	39.	0.21	8.
6.5M	33.	0.24	8.
7.5M	28.	0.13	8.
8.5M	29.	0.17	7.
9.5M	26.	0.24	7.
10.5M	30.	0.16	6.
11.5M	43.	0.23	5.
12.5M	32.	0.15	5.
13.5M	31.	0.17	4.
14.5M	19.	0.22	4.
15.5M	26.	0.07	4.

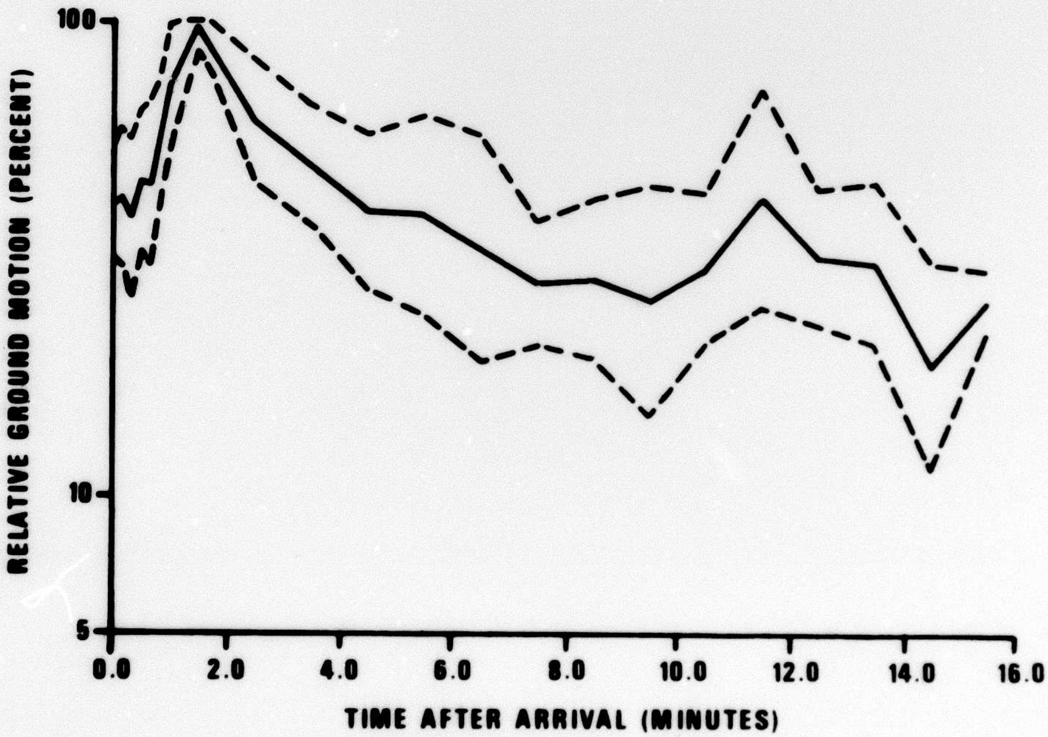

Figure AIII-3. Large-event coda averages, 110-115°.

TIME	AVG	STD DEV	OBS
0.0S	35.	0.32	9.
10.0S	40.	0.20	9.
20.0S	46.	0.19	9.
30.0S	46.	0.20	9.
40.0S	38.	0.19	9.
50.0S	41.	0.12	9.
1.0M	40.	0.07	9.
1.5M	95.	0.07	9.
2.5M	46.	0.19	9.
3.5M	41.	0.15	9.
4.5M	33.	0.15	8.
5.5M	31.	0.13	7.
6.5M	25.	0.19	7.
7.5M	21.	0.26	7.
8.5M	23.	0.29	6.
9.5M	21.	0.33	6.
10.5M	37.	0.24	6.
11.5M	37.	0.20	6.
12.5M	25.	0.29	6.
13.5M	24.	0.32	5.
14.5M	26.	0.35	5.
15.5M	14.	0.20	4.

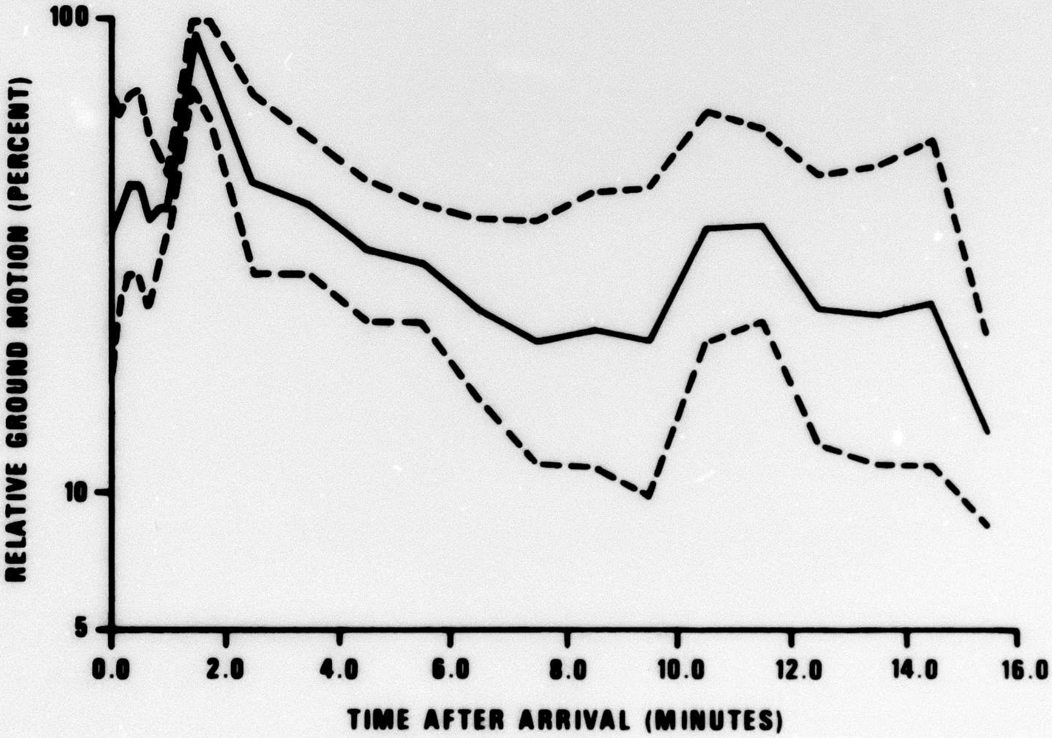

Figure AIII-4. Large-event coda averages, 115-118°.